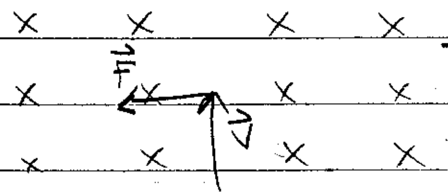
(5)

HW#5 - SOL^N - ADAM COHEN

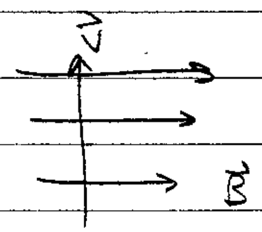
Chapter 19 - Magnetism

(2) magnetic force: direction indicated by right-hand-rule (the direction ⊥ to $\vec{v}$ and $\vec{B}$)

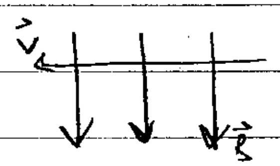
a)


$\vec{B}$ is into page

(left)

b)


$\vec{F}$ is into page (X)

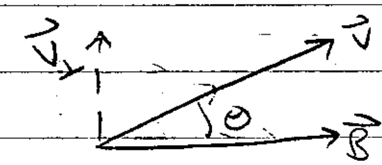
c)


$\vec{F}$ is out of page (·)

d)

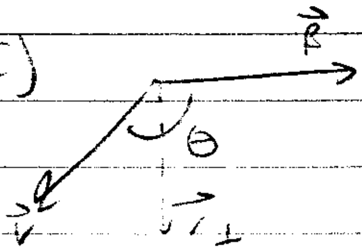

$\vec{B}$ is out of page

$\vec{F}$ is up

e)


(only care about $\vec{v}_\perp$, the ⊥-component of $\vec{v}$ to $\vec{B}$)

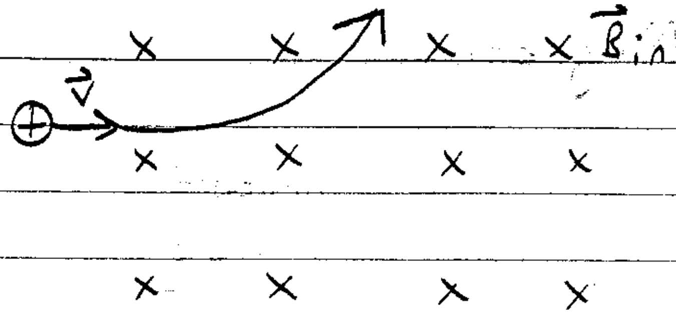
⇒ $\vec{F}$ is into page

f)


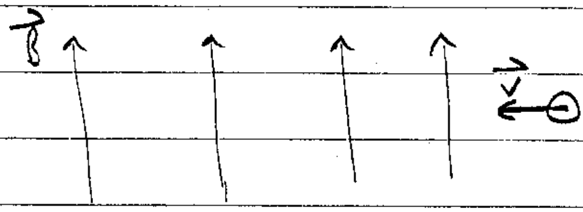
$\vec{F}$ is out of page

For a negatively charged electron, force is reverse of RHR.

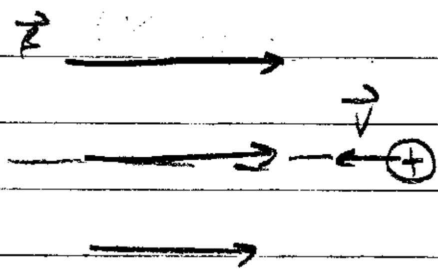
4



(up)

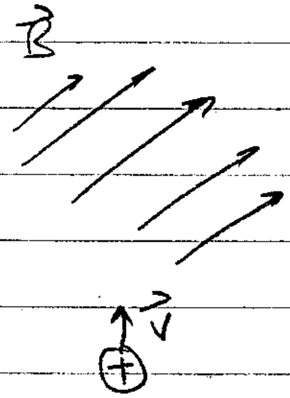


(out of the page)



$\vec{v} \parallel \vec{B} \Rightarrow \vec{F}_B = 0$

so no acceleration, remains in its leftward course.



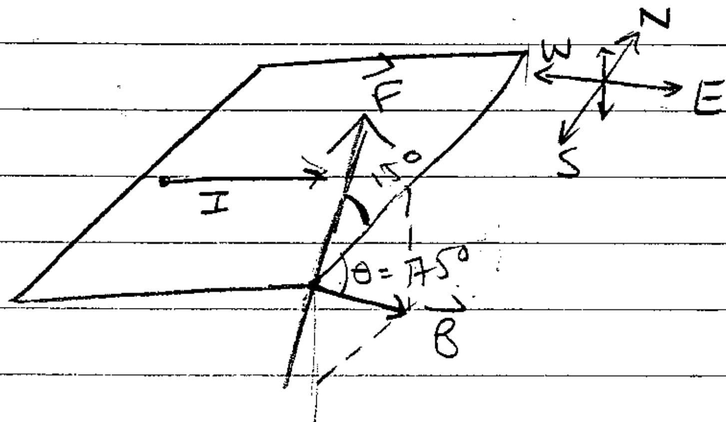
, only care about $\perp$ components $\Rightarrow$

(into the page)

⑫ The current I is defined as the flow of <u>positively</u> charged particles.

So the answers for the direction of force on a wire with positive current is the same as our answers for a proton. See problem ②.

⑯



- $\vec{B}$ has a N component and a down component.
- If I is Eastward, the
  I ⊥ N , I ⊥ down
  ⇒ current is ⊥ to $\vec{B}$
  so θ = 90°
- So the magnitude of the magnetic force on the wire is:

$$|\vec{F}| = B\,I\,\ell \sin\theta$$

$$= (0.6\times10^{-4}\,T)(15A)(10m)\sin 90^\circ$$

$$\boxed{F = 9.0\times10^{-3}\,N}$$

- the direction of $\vec{F}$ must be ⊥ $\vec{I}$, $\vec{\ell}$

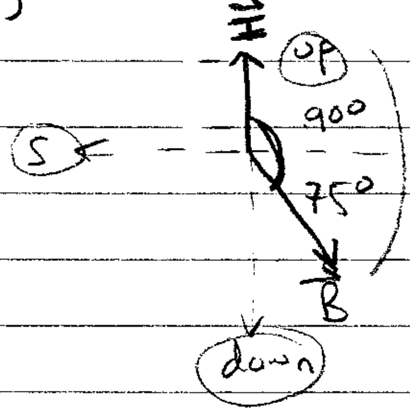
- this leaves 2 directions, use RHR to break the tie

⇒ $\vec{F}$ points 15° above the horizontal in the Northward direction.

(b)

- if now $\vec{I}$ is up.
  - up ∥ down, up ⊥ N
  so only N component of $\vec{B}$ will effect force.

by RHR the force will be **West**

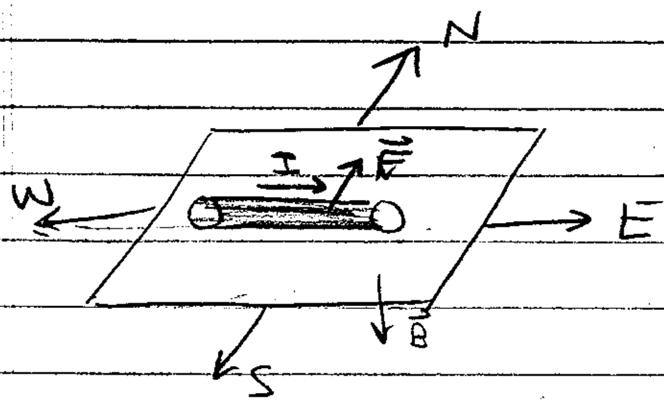


$165° = \theta$

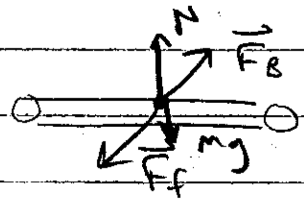
so $F = (0.6\times10^{-4}\,T)(15\,A)(10\,m)\sin(165°)$

$$F = 2.3\times10^{-3}\ N$$

(17)



by RHR, $\vec{B}$ must be **downward** to exert a Northward force.



Freebody diagram

to keep a constant velocity (no acceleration):

$\sum F = ma^{0} = 0$, Newton's Second Law

$F_B - F_f = 0$

$(BIl\sin\theta) - (\mu N) = 0$

$BIl\sin 90° - \mu mg = 0$ ($\sin 90° \to 1$)

$BIl = \mu mg$

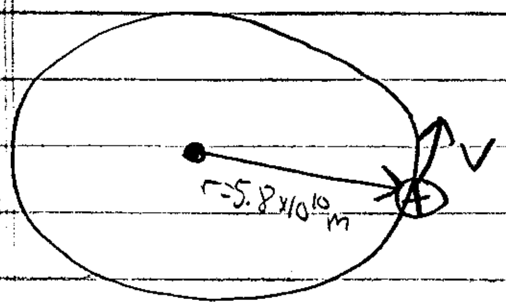
$B = \frac{\mu mg}{Il}$; $\mu = 0.2$; $\frac{m}{l} = 1\ g/cm\left(\frac{1\,kg}{1000\,g}\right)\left(\frac{100\,cm}{1\,m}\right)$

$= 0.1\ kg/m$

$g = 9.8\ m/s^2$, $I = 1.5A$

so $\boxed{B = 0.131\ T}$

(28)



the particle has 10 MeV of Kinetic energy

$$KE = 10\text{ MeV} = 10^7 \cancel{eV}\left(\frac{1.6\times10^{-19}\text{ J}}{1\cancel{eV}}\right) = 1.6\times10^{-12}\text{ J}$$

recall $KE = \frac{1}{2}mv^2$

and mass of proton $= 1.67\times10^{-27}$ Kg

so $v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2(1.6\times10^{-12})}{(1.67\times10^{-27})}}$ m/s

$= 4.37\times10^{7}$ m/s

$=$ 14% of the speed of light (!)

from Newton's Second Law:

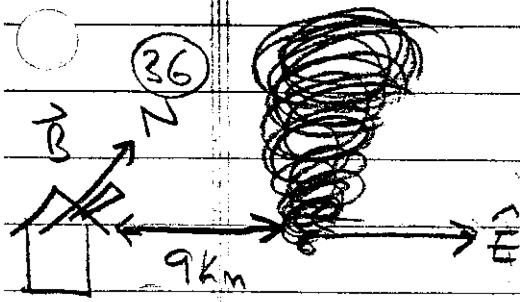
$\sum F = ma$

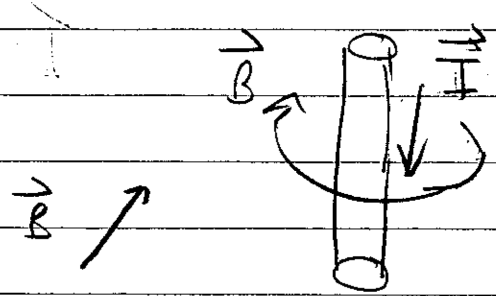
$F_B = ma = \frac{mv^2}{r}$ → circular motion

$q\cancel{v}B = \frac{mv^{\cancel{2}}}{r}$ → since $\vec{v} \perp \vec{B}$ ($\sin 90° = 1$)

$$\Rightarrow B = \frac{mv}{qr} = \frac{(1.67\times10^{-27}\text{ Kg})(4.37\times10^{7}\text{ m/s})}{(1.6\times10^{-19}\text{ C})(5.8\times10^{10}\text{ m})}$$

$$\boxed{|\vec{B}| = 7.88\times10^{-12}\text{ T}}$$





- by RHR, to get a Northward $\vec{B}$-field East of the tornado, current must flow **downward**

- the magnetic field strength of a wire is:

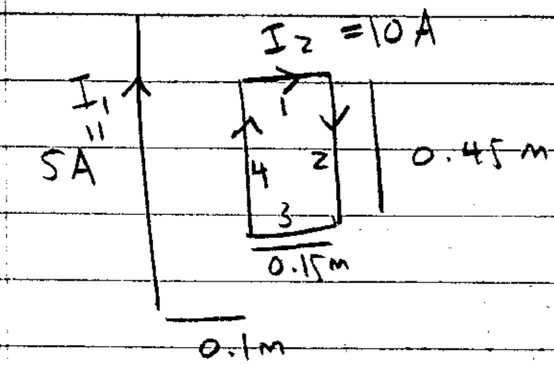
$$B = \frac{\mu_0 I}{2\pi r}$$

$$\Rightarrow \quad I = \frac{2\pi r B}{\mu_0};$$

$r = 9\text{ km} = 9000\text{ m}$
$B = 1.5\times10^{-8}\text{ T}$
look up μ_0

$$\boxed{I = 675\text{ A}}$$

(4b)



- Notice that the force on the top and bottom of the loop are equal and opposite
- so only consider left and right sides of loop.

$$F_{net} = F_{left} + F_{right}$$

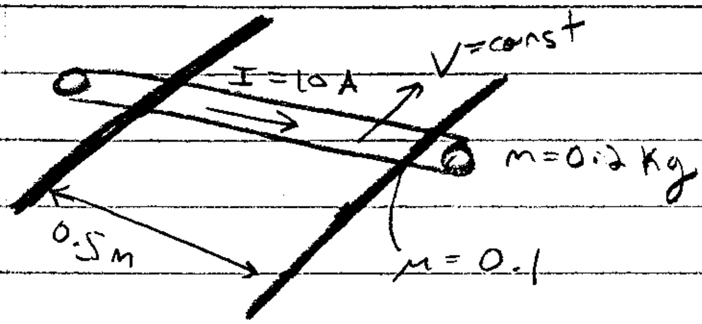
$$= \frac{\mu_0 I_1 I_2 l}{2\pi (0.1m)} - \frac{\mu_0 I_1 I_2 l}{2\pi (0.25m)}$$

$$= \frac{\mu_0 I_1 I_2 l}{2\pi} \left(\frac{1}{0.1m} - \frac{1}{0.25m} \right)$$

$$= \cdots = \boxed{2.7 \times 10^{-5} N}$$

(this is **attractive**, or to the left)

(54)



($\vec{B}$ must point down to move the rod away)

$\rightarrow \vec{B} \perp \vec{I}$

constant speed $\Rightarrow \Sigma F = 0$

$$F_B - F_f = 0$$

$$BIL - \mu N = 0$$

$$BIL - \mu mg = 0$$

$$BIL = \mu mg$$

$$B = \frac{\mu mg}{IL}$$

$$= \frac{(0.1)(0.2)(9.8)}{(10)(0.5)} \text{ T}$$

$$\boxed{B = 3.92 \times 10^{-2} \text{ T}}$$